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WORK INPUT COMMAND DEVICE
[WO-KU TOUNYUU SHIHYOU SOUCHI]

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[Scope of the Patent Claims]

[Claim 1] A work input command device that is characterized by having,

in a work input command device with optimal work input to an assembly line from a plurality of work that is stored in a plurality of storages that have work which is sent to an assembly line from a set production line temporarily stored in set individual groups,

an environmental state detecting means for detecting the environmental state which includes that types and method of work within storage and within an assembly process,

a command rule storage section with a plurality of command rules stored that are applied for selecting work that should be input,

a higher rank rule storage section with higher rank rules stored that correspond with the set environmental state conditions and the abovementioned command rule,

a command rule detecting section for detecting a command rule that should be applied from an environment state that is detected by the abovementioned environmental state detecting means and a higher rank rule that is stored in the abovementioned higher rank rule storage section,

a work input command section wherein a work input command is executed that is desired for this command rule by reading a command rule from a command rule storage section that is determined by a command rule determining section.

[Claim 2] A work input command device as claimed in Claim 1 that is characterized by having a ratio differential rule wherein a command rule for each work

constraint which includes the type and method of work that is determined for input work selection having a ratio within storage that is more than a the upper limit set threshold value and input to a line being constructed by prioritizing work that satisfies the work constraint when the differential of the said ratio is positive, further, the input is controlled by prioritizing the work that satisfies the constraint when the ratio within the abovementioned storage is less than the lower limit set threshold value and the differential value of the ratio is negative.

[Claim 3] A work input command device as claimed in Claim 1 that is characterized by having a ratio integration rule wherein a command rule, for each work constraint which includes the various types and methods of work that are determined for input work selection, compares the integral value of a ratio within storage for a set range time and the ratio integral value which is calculated from the set production ratio, selects input work by prioritizing work that satisfies the work constraint.

[Detailed Explanation of the Invention]

[0001]

[Industrial Field of Application] The present invention pertains to an input method of work for a production process, and especially pertains to an input method of work that improves the production efficiency while maintaining the standardization of work when work is input to a cross-current production line.

[0002]

[Prior Art] Production within a factory, for example, a vehicle production line often has production of a plurality of various products on the same line for respective lines, and recently, minimal production of many product types had generalized the types

of products that are produced on the same line particularly which increased without diversification of preferences of the consumer.

[0003] Further, the production line, for example, a vehicle paint line or assembly line or such desirably performs production advancing management of the equipment or operation, the operating capabilities of the entirety are improved and thus must be supplied to each line by optimal combining of the automobile work conveyance sequence agreeing with each line.

[0004] For example, the sequence of the vehicles that flow on the line is managed relative to set constrains in order to standardize the assembly operation time requirement and component expenditure interval for an automobile assembly factory that produces a plurality of automobiles and vehicles and such. That is, automobiles that have the same conditions require aligning with standardizations such as being at a set interval. Thus, an optimal sequence can be planned by taking [into consideration] each prior line during the production planning, and assembly can be initiated from the body housing line in that sequence.

[0005] However, regardless of this same initial determination, generally, re-input is frequently performed by 2 repeats for the latter adjustment of paint quality inferior vehicles, returned vehicles and two-tone colored vehicles to the intermediate paint line for painting and such. Further, the conveyance sequence of the vehicle work of a production starting point (for example, the sequence during the body welding) is hindered, and the necessity of re-input to a position without hindering standardization develops when automobile work is re-input to a line undesirable during production advancement management for conveyance modification up to a final line by a sequence like that.

[0006] Thus, a plurality of storages are equipped in an automobile assembly plant that temporally store conveyed vehicle work for individual set groups between a downstream side of a set production line and the upstream side of a pre-process. Further, the conveyance sequence of vehicle work (for example, the conveyance sequence during body welding) at the production starting time is hindered, and the conveyance is undesirable upon production promotion management by modifying until the final line by the sequence as it is, and the rearrangement of the conveyance sequence is performed so that the standardization is not hindered when vehicle work is re-input to a line.

[0007] Constraints are established in plurality based on the vehicle type and methods and are as shown in the publication of Japanese Koho Patent No. H03043114 when vehicle work is selected that is input to the next process line from this storage, testing of the constraints is performed, and automobile work that satisfies the abovementioned constraints is extracted as the input vehicle.

[0008] The input work is tested with the sequence constraints as the test from a state with a low importance when a vehicle work that satisfies the constrains is not apparent. Inversely, the target aspect ratio is calculated for each input candidate vehicle when input candidate vehicles exists in plurality, the input candidate vehicle that exhibits a target aspect ratio with the maximum value is determined and that input candidate vehicle is the input vehicle.

[0009] As shown above, the work input command to the assembly process from storage is performed according to set rules.

[0010]

[Problems to be Solved by the Invention] However, the input work is determined by application according to the sequence that is predetermined for the set state according to prior vehicle work input methods, thus

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there were problems like candidate work being inadequate in storage for selection input of concrete work, and vehicle work cannot be stored in desirable storage capacity with uniformity within the storage and standardization of the input work not being possible.

[0011] Thus, the present invention has the objective of offering a work input command device that can standardize the input work by modifying and increasing the constraints for testing the input work.

[0012]

[Means for Solving the Invention] The present invention, as shown in Figure 1, 1st has a work input command device, with an optimal work input to an assembly line from a plurality of work that is stored in a plurality of storages that temporarily store work that is conveyed to an assembly line from a set production line in a set group, which is characterized by having an environmental state detecting means 1 for detecting the environmental state including the work type and methods within storage and within an assembly process, a command rule storage section 9 for storing a plurality of command rules that are applied for selecting work that should be input, a higher rank rule storage section 5 for storing higher rank rules corresponding to the set environmental state and the abovementioned command rules, a command rule determination section 3 for determining command rules that should be applied from the environmental state that is detected by the abovementioned environmental state detecting means and the higher rank

rules that are stored in the abovementioned higher rank rule storage section, and a work input command section 7 that performs work input commands according to this command rule by reading a command rule that is detected by command rule detecting section 3 from command rule storage section 9.

[0013] Further, 2nd, is characterized by a command rule in an abovementioned 1st construction being characterized by having a ratio differential rule wherein a command rule for each work constraint which includes the type and method of work that is determined for input work selection having a ratio within storage that is more than a the upper limit set threshold value and input to a line being constructed by prioritizing work that satisfies the work constraint when the differential of the said ratio is positive, further, the input is controlled by prioritizing the work that satisfies the constraint when the ratio within the abovementioned storage is less than the lower limit set threshold value and the differential value of the ratio is negative.

[0014] Also, 3rd, is characterized by a command rule in an abovementioned 1st construction being characterized by having a ratio integration rule for each work constraint that includes the work types and methods that are determined for input work selection that selects the input work by prioritizing the work that satisfies the work constraints when a ratio integral value is attained which is calculated with the integral value of the ratio within the abovementioned storage calculated from the set production ratio by comparing the integral value of the ratio within storage in an set range time and the ratio integral value that is calculated from a set production ratio.

[0015]

[Utilization] An environmental state detecting section 1 detects the environmental state including the work types and methods within storage and within an assembly process, in a work input command device based on an abovementioned 1^{st} construction of the present invention in the higher rank rule storage section 5, the higher rank rules are stored that correspond to the set environmental state and the abovementioned command rules, thus the command rule determination section 3 determines the command rule that should be applied from the environmental state that is detected by the abovementioned environmental state detection means 1 and the higher rank rules that are stored in the high rank storage section 5. Next, in command rule storage section 9, a plurality of command rules is stored that can be applied for selecting the work that should be input thus the work input command section 7 reads the command rule that is determined by the command rule determination section 3 from the command rule storage section 9, and work input command is performed according to this command rule.

[0016] The optimal sequence can be modified by the set environmental state by establishing the higher rank rules according to a work input command device in the present invention, and the optimal sequence of the command rules can be freely modified by adding and modifying the higher rank rules, and the optimal sequence of the command rule is not fixed, and problems do not develop like the candidate work within storage being unsatisfactory and work not being able to be uniformly stored in desirable storage within the said storage.

[0017] Next, according to the ratio differential rule as in 2^{nd} construction, the differential value of the ratio of the set value and [value] within storage are considered,

and control by the ratio being high prioritizes input of the work in the increasing trend and, inversely, the ratio being lower has input by prioritizing the work in a decreasing trend, thus the fluctuations of the ratio within storage can be predicted; for example, when the ratio within storage is high for the current [content] there is a decreasing trend, and the problem is solved for the ratio being lowered by input by prioritizing by dependency is solved by the abovementioned ratio prioritizing rule, further, inversely, the problem of the ratio increasing when the ratio is low with an increasing trend.

[0018] Next, according to the ratio integration rule of a 3rd construction, control is performed by comparing the integral value of the ratio within storage in the set range time and the ratio integral value that is calculated from the set production ratio, thus the fluctuation within the storage can be determined, and that shift is to an extent that is absorbed even when the ratio temporarily shifts.

[0019]

[Examples] Examples of the present invention are explained using the figures.

[0020] First, an example of a line construction that is applied for a work input command device of the present invention is explained. Recombining of a conveyance sequence between a paint line and an assembly line is explained as an example.

[0021] As shown in Figure 3, the conveyance sequence of the vehicle work 22 that is conveyed by conveyor 20 from paint line that is a preprocess and the conveyance sequence of the vehicle work 22 that is supplied toward the assembly line which is a post-process by conveyor 24 is performed, and a plurality of storage 26 is established for temporary storage of vehicle work in individual groups between the aforementioned conveyors 20, 24.

Storages 26a, 26b, 26c of the 3 line types of the First-In-First-Out types are arrayed and positioned in parallel for storage 26. Thus, conveyor 28 is orthogonally positioned for classification between the conveyor 20 and storages 26a, 26b, 26c for storing within the storages 26a, 26b, 26c corresponding to the vehicle work 22 that is conveyed by conveyor 20 from the paint line. The vehicle work 22 that comes by conveyance by conveyor 20 is conveyed to the entrance of storage 26 corresponding to the retransfer on the temporary classification use conveyor 28. Thus, classification use conveyor 28 is interrupted when the vehicle work 22 reaches the entrance of corresponding storage 26, and the vehicle work 22 is stored within storage 26. In this way, the vehicle work 22 that is stored within storage 26 is positioned in queue in a set interval with the work piece 22 that is previously stored by supply toward the front.

[0022] Further, supply use conveyor 30 is orthogonally positioned between the exit side of each storage 26a, 26b, 26c and the conveyor 24 for input of the vehicle work 22 that is stored within storage 26 toward the conveyor 24 of the assembly line. Vehicle work 22 that satisfies the set conditions among the vehicle work 22 that is stored in each storage 26 is temporarily retransferred to supply use conveyor 30 from the exit of storage 26, and conveyed to the front position of conveyor 24. The conveyor 30 is temporarily interrupted in this state, and the vehicle work 22 is retransferred on the conveyor 24.

[0023] In this way, the vehicle work 22 that is stored within the storage 26 is sequentially selected, and the vehicle work 22 can be sequentially conveyed in a desired sequence toward the assembly line. Further, as abovementioned, the storage 26 is

explained when there are 3 storages 26a, 26b, 26c, this is not limited and can be 4 or more.

[0024] Which vehicle work is input among the vehicle work that is stored within storage 26 is input to an assembly line is determined by work input command device A based on an examples of the present invention which is explained below.

[0025] The work input command device A, as shown in Figure 2, has an environmental state test section 11 as an environmental state detection means, a calculation section 12, a higher rank rule storage section 15 and a command rule storage section 19. Here, the calculation section 12 has an evaluation section 13 as a command rule determination section and a work input command section 17.

[0026] Here, the abovementioned environmental state detection section 11, as shown in Figure 2, sends the environmental state information like the reserve vehicle information and the vehicle queue information is sent to the calculation section 12. Here, the reserve vehicle information is the information about the number of vehicles of the reserve vehicle work that should be placed in reserve for input as lacking the assembly components and such, further, the vehicle queue information, as shown in Figure 2, is information about the vehicle work types and methods, and information about the pass-through limit switch (LS) of the vehicle work that is conveyed out from the storage and information about the numbers of vehicles of vehicle work that are conveyed from storage are included.

[0027] Next, the command rule storage section 19 stores a plurality of command rules that can be applied for testing the work that should be input. Further, the higher

rank rule storage section 15 stores the set environmental state and the corresponding higher rank rule.

[0028] Here, the higher rank rule, as shown in Figure 2, can be classified into "input waiting higher rank rule" and "command rule application sequence higher rank rule", as shown in Figure 4, the rules that are constructed by the conditional section and the execution section in an "IF ~ THEN" form are constructed with arrangement in numerical sequence, and the abovementioned conditional section indicates the set environmental state.

[0029] The abovementioned "input waiting higher rank rule" is a rule that determines when input to an assembly line waits, for example, the higher rank rule of "IF quantity (colored line) > 100 THEN wait (5 minutes)" of Rule No 1 (rule name "*input waiting") in Figure 4 corresponds to "input waiting higher rank rule", and the rule contains "when number of vehicles colored, that is, the number of vehicles until process which performs actual assembly of for an assembly line is 100 or more, wait 5 minutes to lift".

[0030] Further, the "command application sequence higher rank rule", since the application sequence of the respective command rules that are applied for detecting the input work is determined, corresponds to the higher rank rule of "IF ratio (specification a) > production ratio + 10 THEN rule application (constraint, reserve, ratio priority, first priority" higher rank rule of (rule name "*ratio over") of Rule No 2 in Figure 4 corresponds to "command rule application sequence higher rank rule, and the rule contains "command rule application sequence as constraint rule -> reserve rule -> ratio priority rule -> priority rule when the ratio within the storage of specification a is larger

than a set production ration +10%". The rule of Rule No. 3 (rule name "*ratio normal") is also the same as Rule No. 2, and the rule constraints "command rule application sequence as constraint rule -> reserve rule => establishment ratio rule > priority rule when the ratio within the storage of specification a is a set production ratio + 10% or less". Arbitrary additions or modifications are possible for this higher rank rule.

[0031] Here, a plurality of command rules that are stored in command rule storage section 19, as shown in Figure 2, are classified as "A. control rule group" and "B. priority rule group", and as the abovementioned "control rule group" can include constraint rule, reserve vehicle control group and the like, and as "priority rule group" are classified in "(1) Ratio Control Series" and the ratio priority rule, establishment ratio rule, ratio differential rule are classified as "(2) Dispersion Control Series", the dispersion scattering control rule is classified as "(3) Other" and the first priority rule, long term parking priority rule,

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set line priority rule, full vehicle line priority rule and such can be included. The details of the abovementioned respective command rules are latter-mentioned.

[0032] Next, An evaluation section 13 in a calculation section 12 sequentially tests with the higher rank rule that is stored in the higher rank rule storage section 15 based on the environmental state information from environmental state detection section 11 when the calculation section 12 sends environmental state information is sent out from the environmental state detections section 11, and the information about the execution content for the executable higher rank rule, for example, information is sent to work input

command section 17 about the one that has the input or the application sequence of the command rule.

[0033] Next, work input command section 17 sends information of the execution content which is sent from evaluation section 13 and that execution content is commanded. Then, the execution content, for example, one having the 5 minute put-down is commanded when the input wait higher rank rule is executed, and the said command rule is applied by sequentially reading the command rules from the command rule storage section 19 when a command rule application sequence higher rank rule is executed, and the input work is selected and determined and the selected vehicle work input command is output.

[0034] When explaining the handling operation for the abovementioned calculation section 12 according to the flow chart, as shown in Figure 5, the evaluation section 13 in the calculation section 12 performs application handling of the higher rank rule by switching the higher rank rules, that is, sequentially reading out the higher rank rules from the higher rank rule storage section 15 and performs determination of the execution content. That is, the application sequence of the one with input waiting or the applied command rule is determined (Step 001). Next, work input command section 17 sequentially applies the higher rank rule according to the application sequence of the higher rank rules from the evaluation section 13, and selects the input vehicle work (Step 002). Thus, the input command is output when the vehicle work that should be input is determined (Step 003, 004), and returns to Step 1 when the vehicle work that should be input cannot be determined for 1, and another higher rank rule is tested.

[0035] Here, when explaining the handling operation for an evaluation section 13 in further detail, as shown in Figure No. 6, the fetch of the higher rank rule is performed by the higher rule storage section 15. That is, the higher rank rule is read out (Step 011). Next, the higher rank rule is matched, that is, the higher rank rule state section and the current environmental information are collated (Step 012) and operates according to the execution section of the higher rank rule when collated (Steps 013, 015). That is, for example, information about the command rule application sequence is sent to the work input command section 17. Further, when not collated in Step 012, whether or not there is another higher rank rule is evaluated (Step 014), returning to Step 011 when there is, and error handling is performed when there is not (Step 016) and is completed.

[0036] Next, when explaining the handling operation for work input command section 17 in detail, as shown in Figure 7, the command rule is fetched when a command rule is applied according to the application sequence of a command rule in the evaluation section 13, that is, the command rule is read out from the command rule storage section 19 (Step 021), and handling is performed according to the command rules that is read out according to the application sequence (Step 022). For example, in the case of rule No. 2 (rule name "*ratio over") in Figure 4, the command rules are applied in the sequence of constraint rule -> reserve rule -> ratio priority rule -> first priority rule. Whether or not there are other command rules is tested (Step 024) when the vehicle work of the input work candidates become 2 or more for these applications (Step 024), and returns to Step 021 when there are, and the next command rule is executed. Further, error handling is performed (Step 025) when there is not another command rule in Step 024, and [this] is completed.

[0037] Higher rank rules are established in the present invention, and the application sequence can be modified by the respective states like the ratio of the vehicle work specifications within the storage, further, the application sequence of the command rules can be freely modified by adding or modifying the higher rank rules, and the application sequence of the command rues is not fixed, thus the problems like the candidate work in storage being insufficient or vehicle work not be able to be uniformly stored in desirable storage within the storage are not generated, and standardization of the input work is possible.

[0038] Next, the respective command rules that are stored in the command rule storage section 19 in Figure 2 are explained.

[0039] <u>Constraint Rule</u> First, as "constraint rule" that is classified in the control rule group, is a rule that is determined from the work conditions (conditions which are required by a work itself like vehicle types, specifications (e.g. whether or not there is a sunroof, whether or not there is an air conditioner))and input conditions (conditions during conveyance of an interval command and a continuous possible number or such of the vehicle work of the same work conditions), for example, rules like "vehicle A must have 2 intervals positioned" or "continuous input of vehicle work with specification a until there are 3".

[0040] <u>Reserve Vehicle Control Rule</u> Further, the "reserve vehicle control rule" is a rule with the vehicle work outside the input vehicle work candidates with input from things like the circumstances like defective products of relative components. The information about the reserve vehicles is obtained from the environmental state detection section 11 as shown in Figure 2.

[0041] Ratio Priority Rule Next, the "ratio priority rule" that is classified in the ratio control series of the priority rule group is explained. This rule classifies the vehicle work that is stored in the storage and the vehicle work that is lifted on the next process line, for example, from Item A to D as shown in Figure 8, and the ratio of the vehicle work of only those within storage and of a set number that is completely lifted are totaled for each item. Here, the vehicle types and the specifications like 4 WD are determined for Items A to D, thus the vehicle work within the storage corresponds to any of the items. Thus, for each item,

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the degree of priority that is established by (within storage ratio) – (completely lifted ratio)/(completely lifted ratio) is calculated, and the vehicle work of items with the highest degree of priority among those is selected as the input vehicle work. Finally, in the case of Figure 8, the vehicle work of Item C with the highest degree of priority is selected as the input work.

[0042] Set Ratio Rule Next, the "set ratio rule" is explained. The preset ratio is determined by the work constraints based on the vehicle type and specifications and such by this rule, and the input vehicle work is selected such as becoming closer to this set ratio. This set ratio is set based on the production target, thus, normally, the latter-mentioned production ratio is taken in the same way. Concretely, the difference of the actual ratio and set ratio is determined when the respective input candidate vehicle work is input, and candidate vehicle work with the least square of the difference is selected as the input vehicle work. That is, based on the equation for the evaluation relationship of:

$Z(i)$ = [sigma] {(actual ratio of vehicle or specifications) – (set ratio of vehicle or specifications)}^{2}

The vehicle work is selected for which this evaluation value $Z(i)$ is least.

[0043] When concretely explained, as shown in Figure 9, the respective set ratios of vehicle type A, Vehicle type b, specification a, specification b and specification c are 30%, 70%, 20%, 30% and 15%. The set ratio is established mainly based on the production target. Here, as shown in Figure 10, the vehicle work of the type as shown for 9 vehicles is input toward the front itself of the assembly line. Next, 2 of vehicle type A, 7 of vehicle type B, 2 vehicles of specification a, 2 vehicles of specification b and 2 of specification c are constructed. Further, the respective types of vehicle work are positioned in the storages 16a, 16b, 16c of the 3 line types, and the vehicle work that is extracted as the input candidate vehicle work is the 2nd vehicle from the exit side of the storages 16a, 16b, 16c of each line type, and the vehicle work of all 6 vehicles has the types positioned as shown in Figure 10. Here, the vehicle works of i= 2, 5, 6 are extracted from among all 6 of the vehicle works as shown in Figure 9 as the vehicle works that satisfy the constraint rule, for example. The vehicle works of the i = 2, 5, 6 are calculated by the abovementioned $Z(i)$.

[0044] Here, for example, when the vehicle work of i = 5 is explained, the vehicle work of i = 5, as shown in Figure 10, is the vehicle work that has the vehicle type B and specification c, further, the vehicle type B increases 1 vehicle and becomes 8 vehicles when this vehicle work is input to the assembly line, and the specification increases 1 vehicle and becomes 3 vehicles. Thus, the actual ratio of the vehicle type A, vehicle type B, specification a, specification b and specification c, as shown in Figure 9, becomes,

respectively, 20%, 80%, 20%, 20% and 30%, and the set ratio when the square of the difference is determined, becomes $(20 - 30)^2 + (80 -70)^2 + (20 - 20)^2 + (20 - 30)^2 +(30 - 15)^2 = 525$.

[0045] As above, the abovementioned Z(i) is calculated for vehicle work of i = 2, 5, 6. Z(i) of the vehicle work of i = 2, 5, 6 respectively becomes 125, 525 and 25 for cases as shown in the abovementioned Figure 9 and Figure 10, and is least when i= 6. Further, [this] is closest to the set ratio when vehicle work of i= 6 is input. Therefore, this vehicle work of i =6 is determined with the input vehicle work to the assembly line. Also, the vehicle work of 9 vehicles from itself that is within the assembly line is explained due to simple explanation for the present invention and actually is to the extent of 100 vehicles, further, this value can be arbitrarily established.

[0046] The present rule performs input of the vehicle work such as approaching the set ratio, thus, when the production target is modified, the input vehicle work can positively approach that production target. Further, for example, the level improvement of the standardization of an input vehicle can be guaranteed since those vehicles are input at a pace of 1 vehicle to 4 vehicles when the set ratio is 25% for the vehicle type.

[0047] <u>Ratio Differential Rule</u> Next, the "ratio differential rule" is explained. The abovementioned respective rules, for applying the respective rules according to the circumstances of the assembly line without being within storage at the time of the determination, this rule looks at the chronological fluctuations of the work constraint conditions like the vehicle types and specifications within storage, and the ratio within storage of the work constraint conditions like the vehicle types and specifications are detected since the input vehicle work is selected, and the said ratio is at or above a an

upper limit set threshold value, and, the said ratio is at or below a lower limit set threshold value as input by priority when the differential value of the said ratio during determination is positive, and the input by priority is controlled when the differential of the said ratio during the determination is negative. That is, the section that is indicated by a is priority input, and the input control by priority is performed for the section that is indicated by b when that ratio shifts as shown in Figure 11 for the said specifications.

[0048] When a case of selecting 1 vehicle from the vehicle work of 3 vehicles that are positioned at the front of the 3 storages is explained as shown in Figure 12 when a concrete example of an application example of this ratio differential rule is shown, for example, the ratio shifts as shown in Figure 13 for specification c, and the differential for the time t1 cannot have the present rule applied since that is within the threshold value range of 5% to 25%. Further, the ratio reaches the upper limit set threshold value for time t1 as shown in Figure 14 for the specification a and the differential value is positive, thus the present rule is applied and the vehicle work that has specification a is prioritized and input. Also, in this example, the production ratio (ratio of vehicle work that satisfies the work constraints for the produced vehicle work) for specification c is 15%, its upper limit set threshold value is 10%, further, the production ratio for the specification a is 20% and its upper limit set threshold value is 10%.

[0049] This ratio differential rule,

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when the ratio within storage of the vehicle types and specifications is at or above the upper limit set threshold value, and, the ratio is raised to an extent for realizing the threshold value when the differential of the said ratio during determination is positive,

thus, also, is prioritized and input due to controlling the ratio becoming large, inversely, the ratio is at or below the lower limit set threshold value and is to an extent that the ratio decreases to smaller than the threshold position when the differential value of the said ratio during determination is negative, thus, also, the input is controlled by prioritizing in order to control the ratio decreasing. Therefore, currently, the problem can be solved of the ratio still decreasing by prioritizing and input by the abovementioned ratio priority rule when the ratio is high within storage but there is a decreasing trend, further, the problem can also be solved of the ratio increasing when the ratio is low but there is an increasing trend.

[0050] <u>Ratio Integration Rule</u> Next, the "ratio integration rule" is explained. This rule also, in the same way as the abovementioned ratio differential rule, gives consideration to the chronological fluctuations of the ratio, thus comparing the ratio integral value (below, production ratio integral value) S_R that is determined from the production ratio for the work constraints like the vehicle type and specifications and the integral value of the ratio within storage for the assembly line (ratio integral vale within storage) S_r at set range time T, and the vehicle work is prioritized and input when the ratio integral value within storage $S_r >$ production ratio integral value S_R. Further, Figure 15, for example, shows the ratio within storage of the vehicle work that has the specification i by curve r(t), and the production ratio is established by R, the ratio integral value within storage S_r is calculated by the following equation when the current time point is t1 and the set range time is T.

[0051]

$$S_r = \int_{t_1 - T}^{t_1} r(t)\,dt$$

Further, the production ratio integral value S_R is calculated by $S_R = R \times T$, thus the ratio integral value S_r that is calculated by this and the production ratio integral value S_R are compared and the vehicle work of the said specification i is prioritized and input when $S_r > S_R$.

[0052] When a concrete application example of the ratio integration rule is shown, the ratio integral value S_r within storage is calculated by the following equation for the set range time of T = 12 with the value of the set production ratio R as 10 and the time point of t = 14 as current when the ratio of the specification a within storage as shown in Figure 16.

[0053]

$$S_r = \sum_{i=0}^{12} r(t_{14-i}, \text{仕様}a) \times \Delta t$$

Further, the production ratio integral value S_R becomes $S_R = R \times T = 10 \times 12 = 120$, thus the vehicle work of specification a is prioritized and input when the ratio integral value within storage becomes $S_r > 120$.

[0054] This ratio integration rule, for example, the current ratio within storage is high but the ratio within storage is small for several days previous, and the problem of work not existing that is input by input by applying a set ratio is solved for cases when the ratio within storage in somewhat decreased by prioritizing and input by looking at

only the current ratio. That is, absorption to that extent is possible for the fluctuations even as the ratio fluctuates chronologically since the integral value of the ratio within the chronological period is also considered.

[0055] Dispersion Variation Control Rule Next, the "dispersion variation control rule is explained. This rule selects the vehicle work that is closest to the ideal interval number of vehicles from among the candidate vehicle work, and determines the variation of the respective work constraints like the specifications when the said candidate vehicle work is input for the respective candidate vehicle work, the total that is calculated after weighting is performed for each work constraint, and the candidate vehicle work with the minimum determined total is selected as the input vehicle work.

[0056] When a concrete application example of this dispersion variation control rule is explained, as shown in Figure 17, line type storages 26a, 26b, 26c, 26d, supply use conveyor 30 and conveyor 24 are established, and the vehicle work is selected that is input to conveyor 24 from the vehicle work that is positioned at the front of the abovementioned respective storages 26a ~ 26d, but, as shown in Figure 17, each vehicle work 31a ~ 31d of specification b, specification a, and specification a and specification b is stored through the respective specification commands for the storages 26a ~ 26d. Further, the vehicle work through the sequential specification command prior to the value, the vehicle work of specification a and the vehicle work of specification b are all input to conveyor 24 of the assembly line.

[0057] The ideal interval number of vehicles is determined from the production ratio for each specification by the dispersion variation control rule. Here, the vehicle of specification a can be produced in a ratio of 1 vehicle in 3 vehicles when the production

ratio of specification a is 33% as in Figure 18. Further, the ideal interval number of vehicles of specification a is 2 vehicles. Likewise, the ideal interval number of vehicles becomes 3 vehicles when the production ratio of specification is 25%.

[0058] Next, the variations are calculated for each specification of the input candidate vehicle work 31a, 31b, 31c, 31d. The variation of the dispersion x_{ji}, relative to the i^{th} specification of the j^{th} input candidate vehicle work, can be determined by the following equation.

[0059] $x_{ji} = \{0-b_j\}^2 * c_{j0} + \ldots + (k-b_j)^2 * c_{jk} + \ldots\}/\{(c_{j0} + \ldots + c_{jk} + \ldots) -1\}$

That is, k is the interval number of vehicles, b_j is the ideal interval number of vehicles, c_{jk} is

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the number of vehicles of vehicle work that is input by each interval number of vehicles.

[0060] Concretely, calculations are as follows. Figure 19 is a graph that shows the dispersion of the interval number of vehicles of every specification of the vehicle work that is input for all of the assembly lines; Figure 19 (a) shows the dispersion relative to the specification a of i = 1^{st} as the specification and Figure 19 (b) shows the dispersion relative to specification b of i = 2^{nd} as the specification.

[0061] Here, when vehicle work 31 is input without a specification command with j = 1^{st}, the dispersion variation x_{11} relative to specification a is:

$x_{11}= \{(1 - 2)^2 X 2 + (2 - 2)^2 x 8 + (3 - 2)^2 x 6 + (4- 2)^2 x 3 +(5 -2)^2 x 4\}/\{(2 + 8 +6 +3 +4) -1\} = 2.55$

as the ideal interval number of vehicles $b_1 = 2$. Further, the dispersion variation x_{12} relative to specification b is:

$$x_{12} = \{(1 - 3)^2 \times 1 + (2 - 3)^2 \times 3 + (3 - 3)^2 \times 4 + (4 - 3)^2 \times 2 + (6 - 3)^2 \times 1 + (7 - 3)^2 \times 2\}/\{(1 + 3 + 4 + 2 + 1 + 2) - 1\} = 4.17$$

as the ideal interval number of vehicles $b_2 = 3$.

[0062] Next, the total of the dispersion variation is calculated by weighting whether there is any serious consideration of the hindrances pertaining to each specification for the dispersion variations relative to each specification. That is, when the specifications which are a standardized subject are present in M units, and the input candidate vehicle work within storage 26 is present in N vehicles, the dispersion variation total E_j of when the j_{th} input candidate vehicle work within storage 26 is input to an assembly line is evaluated by the following equation.

[0063] $E_j = w_1 x_{j1} + w_2 x_{j2} + \ldots + w_i x_{ji} + \ldots + w_M x_{jM}$

That is, w_i is the weighting coefficient when seriously considering any hindrance relative to the i^{th} specification, x_{ji} is the value that shows the aforementioned dispersion variation. In the example, $M = 2$ and $N = 4$.

[0064] Therefore, when $w_1 = w_2 = 1$ in the present example, the total E_1 of the variation when vehicle work 31a is input is:

$$E_1 = x_{11} + x_{12} = 2.55 + 4.17 = 6.72.$$

[0065] Next, the dispersion variation x_{21} relative to specification a is 2.55 identical to x_{11}, when vehicle work 31b of specification b is input as $j = 2^{nd}$. The interval number of vehicles is 2 since vehicle work of specification b exists for all on the assembly line when vehicle work 31b is input. Therefore, $c_{22} = 4$ by adding the slope

section that is shown in Figure 19 (b), and the dispersion variation relative to specification b, x_{22} becomes:

$$x_{22} = \{(1 - 3)^2 \times 1 + (2 - 3)^2 \times 4 + (3 - 3)^2 \times 4 + (4 - 3)^2 \times 2 + (6 - 3)^2 \times 1 + (7 - 3)^2 \times 2\}/\{(1 + 4 + 4 + 2 + 1 + 2) - 1\} = 3.92.$$

[0066] Further, when $w_1 = w_2 = 1$, the variation total E_2 when vehicle work 31b is input is:

$$E_2 = x_{21} + x_{22} = 2.55 + 3.92 = 6.47.$$

[0067] The variation total for each candidate vehicle work is determined as abovementioned and the vehicle work with the least variation total is selected as the input work.

[0068] As above, input vehicle work can be selected as approaching the ideal interval number of vehicles, and specific work is not equipped and input.

[0069] <u>Front Priority Rule</u> Next, the "front priority rule" has input by prioritizing the front vehicle work when the front and a plurality of 2nd vehicle works are selected as the input vehicle work. This is due to the complications when discharging the front vehicle work to a temporary discharge line for input of the 2nd vehicle work.

[0070] <u>Long Term Parking Priority Rule</u> Next, the "long term parking priority rule" prioritizes and selects vehicle work which has been parked for a long period in a case when a plurality of vehicle work of a parking period within storage is selected as the input vehicle work.

[0071] <u>Established Line Priority Rule, Full Parking Line Priority Rule</u> Next, the "established line priority rule" inputs by priority for the set storage, further, the "full parking line priority rule" prioritizes and inputs to storage with a full parking such as

storing within storage by classification by the individual limiting vehicle type and specifications.

[0072] The application sequence of each command rule as above is arbitrarily determined according to the higher rank rule, and becomes as shown in Figure 20 when an example of a higher rank rule is shown that can perform standardization of optimal input vehicle work.

[0073] That is, first, the higher rank rule of rule No. 1 waits for lifting when the candidate vehicle work is less than 14 vehicles for a colored number of vehicles as 100 vehicles. This allows for a number of vehicles for assembly thus waiting for an increase in the number of vehicles of candidate vehicle work, and therefore optimal vehicle work can be input.

[0074] Next, the higher rank rule of rule No. 2 and the higher rank rule of rule No. 4 have ratios within storage of specification a and specification b outside the set range, that is, the command rules are applied in a sequence of constraint rule -> reserve vehicle control rule -> ratio differential rule -> ratio priority rule -> front priority rule -> long term parking priority rule when the production ratio raises to more than +10% and the production ratio decreases lower than -10%; on one hand, the higher rank rule of rule No. 3

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has a ratio within storage of specification a and specification b that is within a set range, and the command rules are applied in a sequence of constraint rule -> reserve vehicle control rule -> ratio integration rule -> set ratio rule -> front priority rule -> long term parking priority rule when the production ratio is within a range of +/- 10%.

[0075] Here, the application of the ratio differential rule when the ratio within storage is outside the set range has the ratio differential rule as abovementioned as the premise when the ratio within storage is outside the set range, further, the application of the ratio priority rule with the problem arising that a vehicle work does not exist that can be input when continuing to apply the set ratio rule to a case when outside the set range since the established ratio rule does not consider the circumstances within storage. On one hand, the application of the ratio integration rule and the dispersion variation control rule when the ratio within storage is within a set range, the ratio integration rule and dispersion variation control rule are applied with the production ratio as standard, thus since the standardization of the input work closer to the production ratio can be performed, the application when within a set range is considered as appropriate, further, the application of the set ratio rule, from the fear being small that the input work will cease to exist although control near the set ratio (production ratio) is performed when the ratio within storage is within a set range.

[0076] Also, vehicle work is explained as an example of work in the abovementioned example, but is not limited to this and can be arbitrary work.

[0077]

[Effect of the Invention] According to a work input command device based on the present invention, an application sequence can be modified by set environmental states, further, the application sequence of the command rules can be freely modified by adding or modifying the higher rank rules, and standardization of input work can be realized by the application sequence of the command rules not being fixed.

[0078] Further, the set threshold value and the differential value of the ratio within storage are considered with the command rule is a ratio differential rule, and the ratio is high and the work with an increasing trend is prioritized and input, inversely, the ratio is low and the input control is by prioritizing the work with a decreasing trend, and the fluctuations of the ratio within storage can be predicted.

[0079] Also, the fluctuation within storage can be predicted even when the command rule is a ratio integration rule, and can be absorbed to the extent of the fluctuations even when the ratio fluctuates over time.

[Simple Explanation of the Symbols]

[Figure 1] is a figure corresponding to the claims for a work input command device in the present invention.

[Figure 2] is a block diagram that shows the construction of a work input command device based on an example in the present invention.

[Figure 3] is an explanatory diagram that shows a line construction based on an example of the present invention.

[Figure 4] is an explanatory diagram that shows an example of a higher rank rule.

[Figure 5] is a flowchart that shows handling operations in an operation section.

[Figure 6] is a flowchart that shows a handling operation in a determination section.

[Figure 7] is a flow chart that shows handling operations in a work input command section.

[Figure 8] is an explanatory diagram for explaining an application example of a ratio priority rule.

[Figure 9] is an explanatory diagram that shows a calculation example of a evaluation value for a set ratio rule.

[Figure 10] is an explanatory diagram for explaining an application example of an set ratio rule.

[Figure 11] is an explanatory diagram for explaining the principle of a ratio differential rule.

[Figure 12] is an explanatory diagram for explaining an application example of a ratio differential rule.

[Figure 13] is an explanatory diagram for explaining an application example of a ratio differential rule.

[Figure 14] is an explanatory diagram for explaining an application example of a ratio differential rule.

[Figure 15] is an explanatory diagram for explaining the principles of a ratio integration rule.

[Figure 16] is an explanatory diagram for explaining an application example of a ratio integration rule.

[Figure 17] is an explanatory diagram for explaining an application example of a dispersion variation control rule.

[Figure 18] is an explanatory diagram for explaining an application example of a dispersion variation control rule.

[Figure 19] is an explanatory diagram for explaining an application example of a dispersion variation rule.

[Figure 20] is an explanatory diagram that shows a desirable higher rank rule.

[Explanation of the Symbols]

1 environmental state detection means

3 command rule determination section

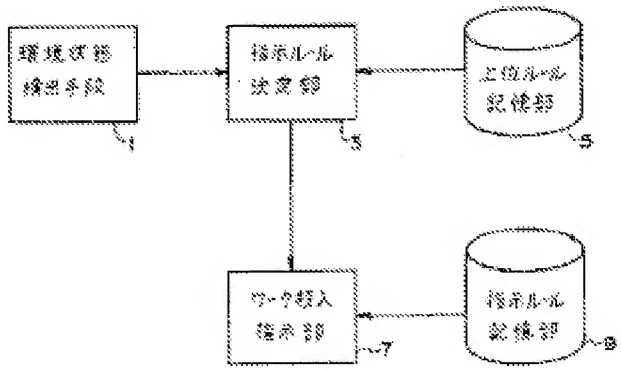
5 higher rank rule storage section

7 work input command section

9 command rule storage section

[Figure 1]

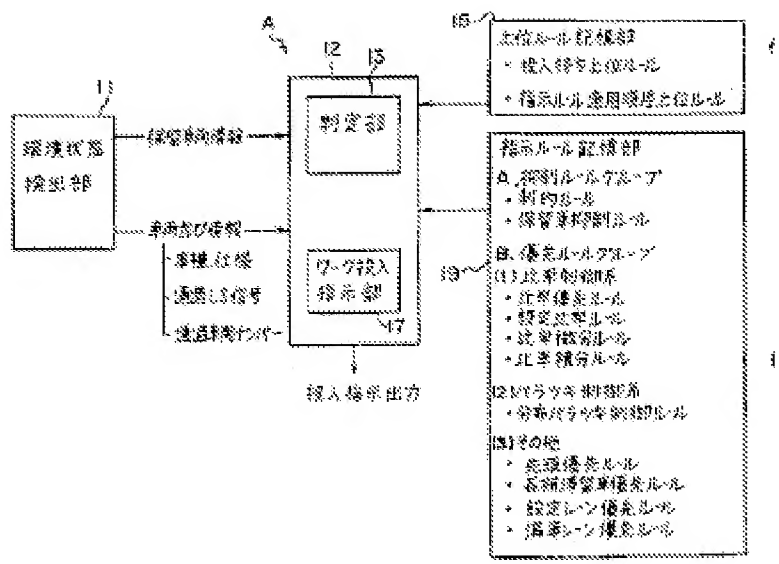
【図1】



1 environmental state detection means
3 command rue determination section
5 higher rank rule storage section
7 work input command section
9 command rule storage section

[Figure 2]

【図2】



11 environmental state detection section

[top arrow] reserve vehicle information

[lower arrow] vehicle arrangement information

- -vehicle type, specifications
- -pass through LS signal
- -pass through vehicle number

13 determination section

17 work input command section

[bottom arrow] input command output

15 higher rank rule storage section

- Input waiting higher rank rule
- Command rule application sequence higher rank rule

19 command rule storage section

A. control rule group

- Constraint rule
- Reserve vehicle control rule

B. Priority rule group

(1) ratio control series

- Ratio priority rule
- Set ratio rule

- Ratio differential rule
- Ratio integration rule

(2) variation control series

- Dispersion variation control rule

(3) Other

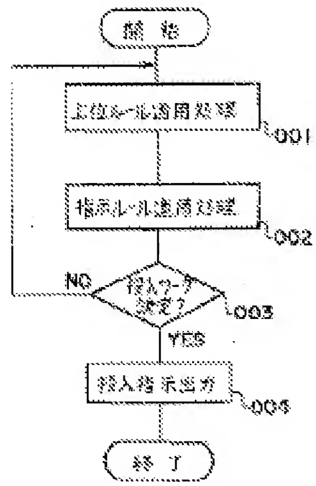
- Front priority rule
- Long term parking priority rule
- Established line priority rule
- Standard line priority rule

[Figure 4]

Rule No.	Conditional Statement	Execution Statement	Rule Name
1:	IF quantity (colored line) > 100	THEN wait (5 minutes)	/*input wait
2:	IF ratio (specification a) > production ratio + 10	THEN rule application (constraint, reserve, ratio priority, front priority)	/*ratio over
3:	IF ratio (specification a) </= production ratio +10	THEN rule application (constraint, reserve, established ratio, front priority)	/*ratio normal
.			
.			
.			

[Figure 5]

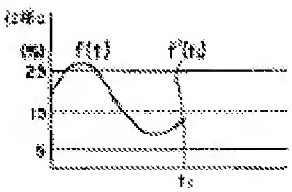
【図5】



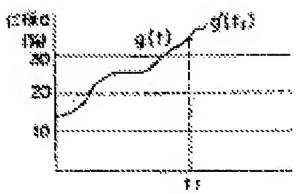
START
001 higher rank rule application process
002 command rule application process
003 input work determined?
004 input command output
END

[Figure 13]

【図13】



【図14】



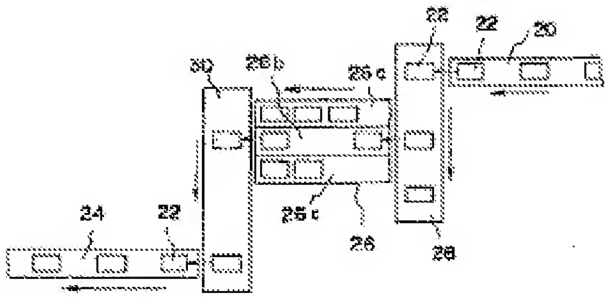
[ordinate]   specification c

/10

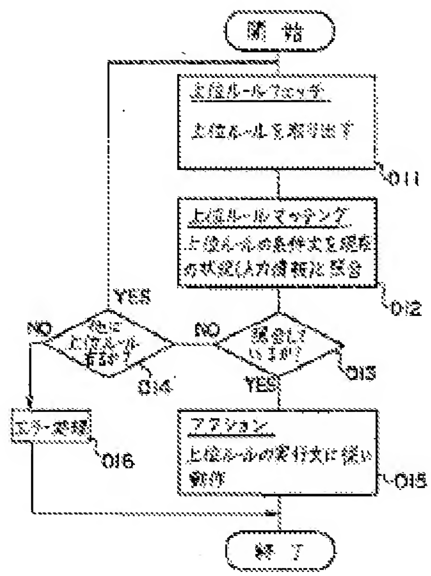
[Figure 14]

[ordinate] specification a

[Figure 3]



[Figure 6]



START

011 higher rank rule check

higher rank rule picked

012 higher rank rule matching

014 higher rank rule had by another? 013 verification?

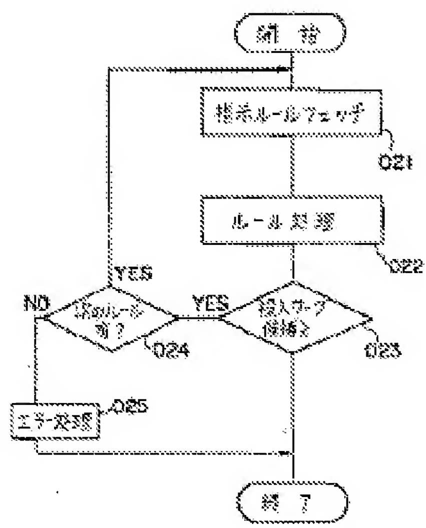
016 error process 015 action

operation related to higher rank rule execution command

END

[Figure 7]

【図7】



START

021 command rule check

022 rule process

024 rule following?

023 input work candidate >/=

025 error process

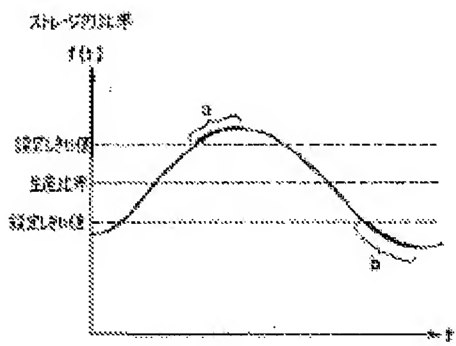
END

[Figure 8]

Item	Ratio Within Storage %	Ratio Completely Lifted %	Degree of Priority	Candidate
A	50	40	(50 – 40)/40=0.25	
B	20	25	(20 – 25)/25=-0.2	
C	10	5	(10-5)/5=1.0	O
D	20	30	(20 – 30)/30=0.33	
/	100	100	/	/

[Figure 11]

[図11]



[ordinate] ratio within storage
f(t)
set threshold value
production ratio
set threshold value

[Figure 12]

			Vehicle A Specification a
			Vehicle B Specification b
			Vehicle B Specification c

[right arrow] assembly input

[Figure 18]

Specification	Production Ratio	Ideal Interval Number of Vehicles
Specification a	33%	2 vehicles
Specification b	25%	3 vehicles

[Figure 9]
Calculated Example of Evaluation Value for Each Vehicle

Conditions	Established Ratio	Vehicle i = 1	i = 2	i = 3	i = 4	i = 5	i = 6
Vehicle Type A	30%		(3 vehicles)/10 30% (0%)			(2 vehicles)/10 20% (-10%)	(3 vehicles)/10 30% (0%)
Vehicle Type B	70%		(7 vehicles)/10 70% (0%)			(8 vehicles)/10 80% (10%)	(7 vehicles)/10 70% (0%)
Specification a	20%		(2 vehicles)/10 20% (0%)			(2 vehicles)/10 20% (0%)	(2 vehicles)/10 20% (0%)
Specification b	30%		(2 vehicles)/10 20% (-10%)			(2 vehicles)/10 20% (-10%)	(3 vehicles)/10 30% (0%)
Specification c	15%		(2 vehicles)/10 20% (5%)			(3 vehicles)/10 30% (15%)	(2 vehicles)/10 20% (5%)
Specification d	None		-			-	-
Constraint Check		X	O	X	X	O	O
Evaluation Z(i)		-	125	-	-	525	25

Result: Vehicle i= 6 with the smallest evaluation value is selected

[Figure 10]

Storage

4	Vehicle B Specification a	Vehicle B Specification a Specification b
5	Vehicle B Specification c	Vehicle A
6	Vehicle A Specification b	Vehicle A Specification a

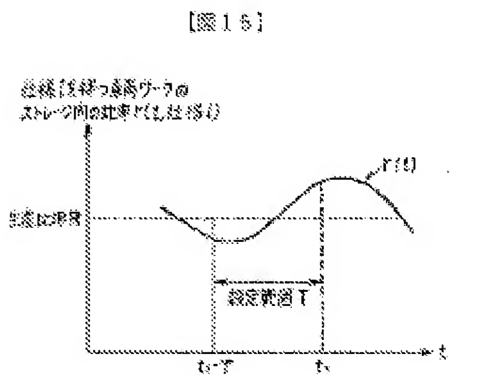
[Left arrow] paint process

Vehicle A Specification a
Vehicle B
Vehicle B Specification b
Vehicle B
Vehicle B
Vehicle B Specification b Specification c
Vehicle A
Vehicle B Specification a
Vehicle B Specification c

|
V
Assembly Process

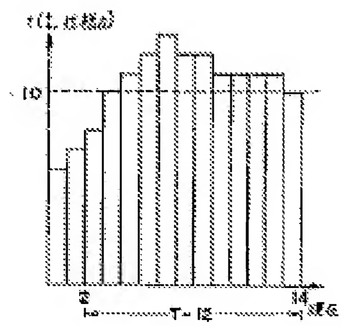
[right side of table] input order
1st vehicle

[Figure 15]



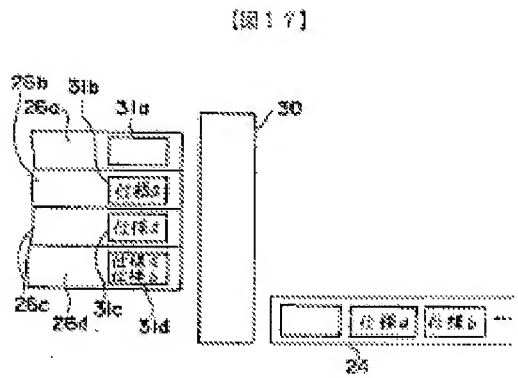
[top] ratio r within storage of vehicle work having specification i (t, specification i)
[ordinate] production ratio R
[center] set range T

【図１６】



[axis] current
[ordinate] r(t, specification a)

[Figure 17]



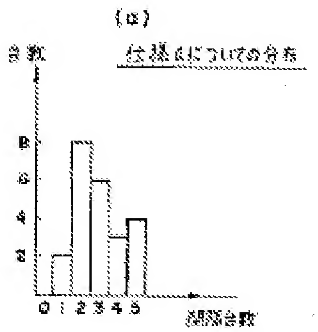
31b specification a
31c specification a
31d specification a
specification b
24 [ ] [specification a] [specification b]

[Figure 19]

(a)

number[?] of vehicles

<u>dispersion for specification a</u>

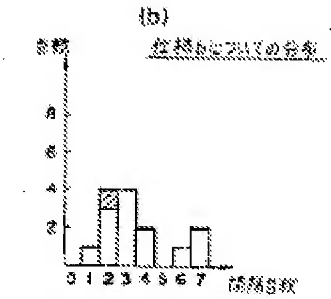


interval number of vehicles

(b)

number[?] of vehicles

<u>dispersion for specification b</u>



interval number of vehicles

[Figure 20]

Meta Rule No.	Conditional Section	Execution Section
1	Number of colored vehicles >/= 100 vehicles & number of candidate vehicles < 14 vehicles	Lifting determined
2	Ratio within storage (specification a & specification b) > production ratio + 10%	Application sequence of rules as follows 1 constraint rule 2 reserve vehicle control rule 3 ratio differential rule 4 ratio priority rule 5 front priority rule 6 long tem parking priority rule
3	Ratio within storage (specification a & specification b) </= production ratio +10% & ratio within storage >/= production ration -10%	Application sequence of rules as follows 1 constraint rule 2 reserve vehicle control rule 3 ratio differential rule 4 set ratio rule 5 dispersion variation control rule 6 front priority rule 7 long term parking priority rule
4	Ratio within storage (specification a & specification b) < production ratio –10%	Application sequence of rules as follows 1 constraint rule 2 reserve vehicle control rule 3 ratio differential rule 4 ratio priority rule 5 front priority rule 6 long term parking priority rule